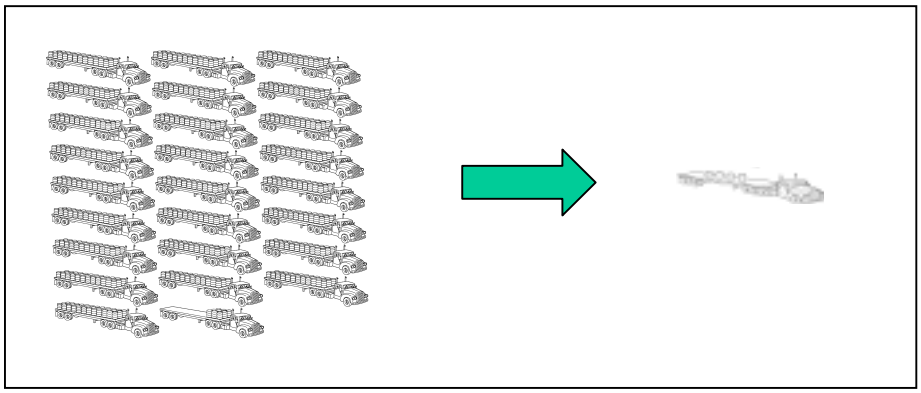
Gas Cleaning Method Dramatically Reduces Consumption of Wet Chemicals In the Semiconductor Industry

SUMMARY

ANON, Incorporated has developed a process for removing organic films and residues from various industrial substrates that requires only exposure to sulfur trioxide gas (SO_3) followed by a simple water rinse. No liquid chemicals are required for thorough removal of a wide variety of tough, organic films and residues. This wet-chemical-free process is applicable in many industries, but is particularly attractive in semiconductor and flat-panel display manufacturing where conventional methods for cleaning are cumbersome, costly, and create large amounts of hazardous and toxic chemical wastes. By substantially reducing the liquid chemicals now used for semiconductor wafer cleaning, as shown below, the ANON SO_3 process can cut the cost of cleaning by more than half.



CONVENTIONAL METHODS
~ 500,000 GALLONS

SO_3 METHOD
~ 500 GALLONS

A Very Large Reduction in the Annual Consumption of Hazardous and Toxic Liquid Chemicals Can Be Expected by a Typical Semiconductor Plant Using the New, Sulfur Trioxide Cleaning Method

BACKGROUND

In the semiconductor industry, a photosensitive organic material called photoresist is used to define the pattern of a semiconductor device on each silicon wafer. After use, the photoresist must be thoroughly removed without leaving any residues before the next manufacturing step can start. Complete removal of photoresist is an integral part of a large number of process steps in semiconductor manufacturing. In fact, as many as 25 out of perhaps 300 manufacturing steps may require thorough removal of photoresist. Conventional techniques used for many years for removing these films and residues require the use of hot solutions of sulfuric acid mixed with hydrogen peroxide and, in many cases, the use of toxic, organic solvents. Usually, where manufacturing processes have hardened the photoresist, a preliminary plasma ashing step is required prior to cleaning with liquid chemicals in order to completely remove the tough film.

VALUE PROPOSITION

In electronics cleaning applications, ANON's sulfur trioxide process has substantial environmental, economic, and technical value advantages over conventional technologies. Perhaps the most dramatic of these is a very large reduction in the use of wet-chemicals and toxic organic solvents. On a comparable-use basis, liquid chemical consumption for photoresist removal can be reduced by roughly 3 orders of magnitude, as illustrated above. The savings in consumables costs, alone, amounts to more than $300,000 **each month** for a typical semiconductor manufacturing plant. The total savings from all sources is twice this amount, or more, and can reduce the cost of cleaning by well over 50%. In addition to such readily quantifiable savings, the manufacturer and the community will also see large reductions in the hazardous and toxic waste stream, as well as reductions in the energy resources consumed during the manufacture, use and disposal of these hazardous chemicals.

The value proposition for this new process is not limited solely to reductions in hazardous and toxic chemical wastes and energy conservation. Other important features of the SO_3 process distinguish it from conventional cleaning methods and offer comparably dramatic improvements in cleaning capability to semiconductor and flat panel display manufacturers. The technical value advantages provided by these features include the ability to completely remove very tough organic films such as high-dose (e16) ion implanted photoresist without leaving residues, the prevention of cleaning damage to sensitive and costly semiconductor wafers, and low temperature, extremely uniform cleaning.

Beyond even these advantages, two of the most significant benefits for manufacturers include the capability for removing tough photoresist in the presence of low-k dielectric films without using damaging oxygen-plasma processes; and reductions in production cycle time and work-in-process inventories resulting from the replacement of a two-step cleaning process (ash plus wet-clean) with a one-step process (SO_3 clean).

BOTTOM LINE

Recognizing such dramatic environmental, economic and technical advantages for both business and the community, the California Energy Commission and the Department of Energy (DOE) provided a substantial grant through the Office of Industrial Technology NICE^3 program (National Industrial Competitiveness through Energy, Environment, and Economics). This grant was instrumental in making this unusual technology available to industry.

Organic film and residue cleaning with SO_3 now offers a radically new approach to industrial cleaning requirements. This is a process that simultaneously meets the needs of high-tech manufacturing, business economics and the environmental concerns of industry in the 21st century….. a criterion for manufacturing whose time has come.